

***Army Research Laboratory***



# **A Proposed Software Design for Weather Effects on Artillery (WEA)**

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13. ABSTRACT (Maximum 200 words)  Work has begun on a software suite that will automate the extraction of weather impacts information on artillery. By combining the information provided by the Battlescale Forecast Model and the Atmospheric Sounding Program with a rule base of thresholds for artillery systems, the user will be able to see either a text display of the effectiveness of a given artillery system or a map overlay demarcating the degree of effectiveness of a particular artillery system. This concept has been developed in software before as the Integrated Weather Effects Decision Aid (IWEDA); however, the application was for a much broader array of military systems as well as personnel. IWEDA has a rule for "artillery"; however, it is generic. Weather Effects on Artillery (WEA) will focus on three specific artillery systems initially: Sense & Destroy Armor (SADARM), Brilliant Anti-Tank (BAT), and Multiple-Launch Rocket System (MLRS). Included in the rule base will be systems used in tandem with artillery such as laser designators. In the alpha version of WEA, 26 rules will be instituted that will reference meteorological parameters including target-area winds, cloud base, precipitation type, winds aloft, turbulence, temperature. IWEDA uses the Joint Mapping Toolkit (JMTK) for its map overlays. WEA will use the Geographic Resources Analysis Support System (GRASS), a very mature geographic information system for the overlay of contours delineating artillery effectiveness information.				
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## 1. Introduction

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In military operations, precise knowledge of the weather and how it will affect operations is critical. Thus, considerable time and effort has been applied to defining the operational weather-related thresholds for both personnel and systems. Artillery is one category of weapon systems in which weather thresholds have been delineated due to the experiences of both equipment testers and military gunners. To address a current Science and Technology Objective, "Deep Attack and Indirect Fire Meteorological Improvement," work is beginning on a software system that will automate the quantification of how a given weather situation will affect a particular artillery or artillery-related system.

This software concept is not new; however, the specific systems that are addressed are new. At the U.S. Army Research Laboratory, White Sands Missile Range, NM, a software system that addresses this type of problem, called the Integrated Weather Effects Decision Aid (IWEDA), has been developed and fielded. IWEDA has a large rule base for how various weather parameters will affect a myriad of systems including aircraft and missiles; entities such as personnel; and nuclear, biological, and chemical constituents. [1]

IWEDA uses weather information from the Battlescale Forecast Model (BFM) and the Atmospheric Sounding Program (ASP) as input and ultimately derives a matrix of systems (and in some cases subsystems). A user can click on one of these to determine whether meteorological (met) conditions for the application of that particular entity have been deemed "favorable", "marginal", or "unfavorable". Another product of IWEDA is a map overlay, which displays color contours demarcating areas. If met information is available, the map overlay shows favorable/marginal/unfavorable areas that, for example, personnel could operate in (temperature effects), helicopters could operate in (wind speed, icing, turbulence effects), etc.

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## 2. Proposed Design

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### 2.1 Building an Artillery-Tailored Decision-Aid Program

*IWEDA is a proven system so why not use it as the foundation for building an artillery-tailored decision-aid program?*

One important reason is that IWEDA was created as a complement to the Integrated Meteorological System (IMETS), which maintains a large database of current met values for several areas such as the continental United States, Southeast Asia, and a theater in Europe. Before the IWEDA rules can be fired, a 4-dimension grid of met data tying all of the key thresholds to a particular point in space and time must be created. Thus, in the case of IWEDA, this means numerous system query language (sql) calls to the IMETS Informix database. For this proposed Weather Effects on Artillery (WEA) software, the preprocessing of met data will instead involve manipulation of flat files of met data.

Secondly, the IWEDA is tied to IMETS; therefore, it uses the Joint Mapping Toolkit (JMTK) software for all of its map overlays. Adopting JMTK for WEA would require a reliance on government contractors in charge of JMTK in case any bugs or other problems were encountered. Instead, we propose the adoption of a very mature, freely available geographic information system (GIS) called the Geographic Resources Analysis and Support System (GRASS) Version 5.06 with which both raster and vector graphics can easily be depicted.

Lastly, although IWEDA has a generic "artillery" entity (from Annex D, METOC Impacts on Operations) in its rule base, it does not focus on the specific artillery systems that this software will, namely, Sense & Destroy Armor (SADARM), Brilliant Anti-Tank (BAT), and Multiple-Launch Rocket System (MLRS). Also to be included in the WEA rule base are systems pertinent to artillery such as laser designators, Unmanned Aerial Vehicle (UAV), Remotely Piloted Vehicle (RPV), and drones. [2]

### 2.2 Hardware/Software

The proposed platform is an Intel system running Linux. The interface will be written in Java (the Java Development Kit [jdk1.3] runs under Linux). Java is able to invoke "native" code such as C/C++. GRASS is Unix-based as well.

BFM will provide gridded wind direction and speed, temperature, and moisture information. ASP uses BFM (and/or another mesoscale model) data as input and derives parameters that can affect artillery such as precipitation type and rate, visibility, turbulence, icing, and cloud layers and ceiling.

A WEA preprocessor will first take the BFM and ASP flat files and extract all the thresholds relevant to the database of artillery systems. In the "alpha" version of WEA, a rule base for six artillery/artillery-related systems will be written. The language for the preprocessor implementation has not been determined. C/C++ will be an option since, as described earlier, Java can call native code.

A rule base encoding of all of the thresholds for each system must also be written. The alpha version of WEA will have 26 rules. For example, SADARM is sensitive to target area winds; MLRS is functional only within a strict temperature range; and UAV, RPV, and drones will be affected by turbulence. The temperature and target area wind information will come from BFM output while the turbulence information will be available in the ASP output.

Once the preprocessing for weather impacts on the artillery systems has been completed, then the information determining if a system is go/marginal/no-go and for what geographic areas has to be passed back to GRASS. This will require system calls to GRASS where the appropriate values to draw contours are passed.

A few samples of the menu driven WEA graphical user interface (GUI) are shown in figures 1 through 3.

From the Program button, the user can learn more about Computer Assisted Artillery Meteorology (CAAM), BFM, or WEA or can exit the program (figure 1). From the Computer Assisted Artillery Meteorology Battlescale Forecast Model (CAAM BFM) button, the user can select "Start," which will pop-up the "java-caam" GUI and allow the user to set up and do a CAAM BFM run. The "Preprocessor" menu item allows the user to kick off this module which will determine how the actual met correlates to the rule base of thresholds for each point in the area of interest (AOI) (as determined by the BFM run), for each system. Text will be periodically displayed indicating progress of the Preprocessor program as seen in figure 2.

The "Impacts" menu item has a submenu of six artillery systems/systems related to artillery. When the user clicks on one of them, a text box will be displayed with information on whether conditions are favorable/marginal/unfavorable for the use of that system. If marginal/unfavorable conditions are listed, the met conditions that caused them will be listed as well (figure 3). Finally, the "Map Overlay" menu will have these same six systems listed. Clicking on any one of them will pop-up a GRASS-based view of either a map or terrain data with color contours illustrating the favorable/marginal/unfavorable areas for a particular system.

Figure 1. Information from the "About CAAM BFM" submenu under "Program" menu.

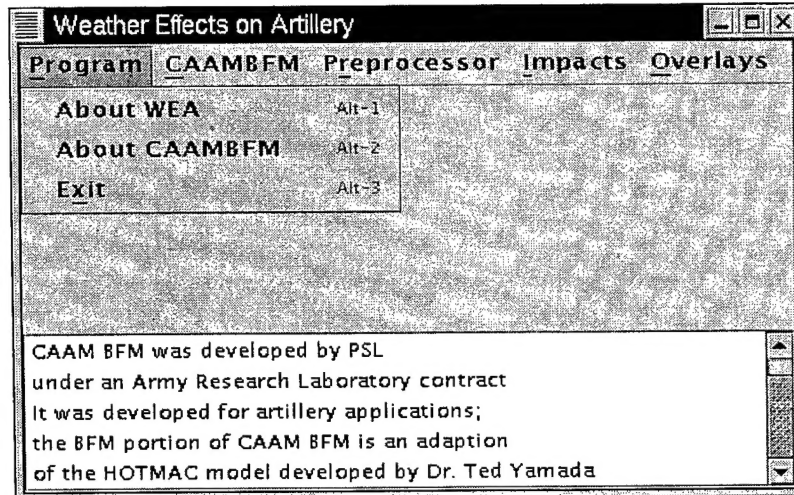
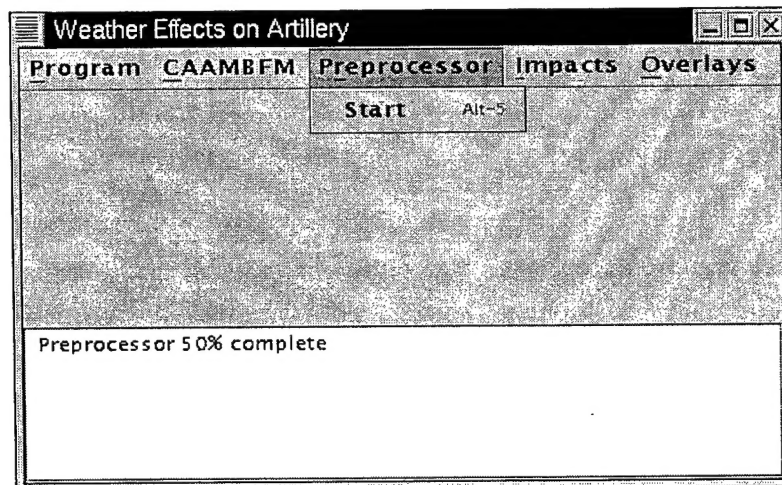
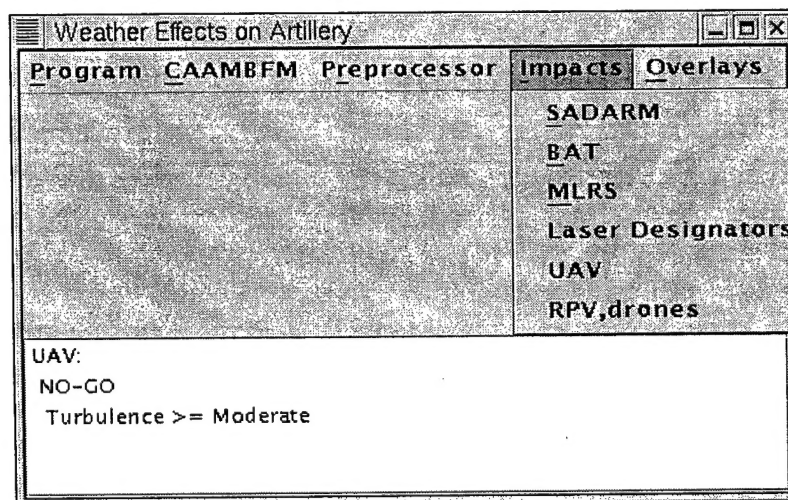


Figure 2. When starting the Preprocessor, the program's progress will be tracked in the text window.



When one of the six "Impacts" submenu items is chosen, a text description will be given as to whether conditions are favorable/marginal/unfavorable for use of that system. Figure 3 is an example of a submenu.

Figure 3. An example when UAV is selected.





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## Reference

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1. Sauter, D. P. "An Interactive Information and Processing System to Assist the Military with Command and Control Decision Making", *Proceedings of the 16th International Conference on Interactive Information and Processing Systems (IIPS) for Meteorology, Oceanography and Hydrology*, Long Beach, CA, pp. 279-282, 2000. (UNCLASSIFIED)
2. Annex D. *METOC Impacts on Operations, Joint Meteorology and Oceanography (METOC) Handbook*, 1999. (UNCLASSIFIED)

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## Acronyms

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AOI	area of interest
ASP	Atmospheric Sounding Program
BAT	Brilliant Anti-Tank
BFM	Battlescale Forecast Model
CAAM	Computer Assisted Artillery Meteorology
CAAM BFM	Computer Assisted Artillery Meteorology Battlescale Forecast Model
GIS	geographic information system
GRASS	Geographic Resources Analysis and Support System
GUI	Graphical User Interface
IMETS	Integrated Meteorological System
IWEDA	Integrated Weather Effects Decision Aid
JMTK	Joint Mapping Toolkit
MLRS	Multiple-Launch Rocket System
RPV	Remotely Piloted Vehicle
SADARM	Sense & Destroy Armament/Armor
sql	system query language
UAV	Unmanned Aerial Vehicle
WEA	Weather Effects on Artillery

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